PATENT SPECIFICATION

585,583

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COMPLETE SPECIFICATION

An Improved Process and Apparatus for the Continuous Crystallisation of Sugar

I, JORGE SAITZEW, of Ingenio Los Ralos, province of Tucuman, Argentine, a Citizen of the Argentine Republic, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to a novel process and apparatus for the continuous boiling and evaporation of sugar cane juices and similar liquids of the sugar industry and it has for its object an improved process and apparatus devised for performing the evaporation or concentration by the continuous boiling of the syrups or the like, instead of the intermittent or periodical treatment heretofore adopted for the purpose, thereby assuring important advantages and industrial profits.

Heretofore, the evaporation or concentration by boiling of sugar cane juices, molasses and syrups in the sugar industry has been performed in an intermittent and periodical manner by the use of vacuum pans of known construction. The operation of obtaining the sugar grain or crystals and developing the same to the required size, draining the mother molasses and discharging the evaporated or concentrated product, is usually performed in the following manner.

A pan is charged with a suitable amount of juice or syrup, in order to provide what is called the "pied de cuite": the syrup is concentrated by evaporation until obtaining an adequate degree of concentration or oversaturation, for forming the initial sugar grains or crystals, thereupon, a so-called crystallizing seed is injected in the shape of sugar powder, in order to create crystallizing nuclei, or; if desired, oversaturation is carried on to a point at which a great amount of sugar crystals will spontaneously form in the liquid.

After securing in either of said ways the formation of the initial sugar crystals, the syrup is submitted to a treatment for steadying the grain (opening the grain or crystals). The operation of establishing "pied de cuite" is preferably performed in a small pan and after securing the formation of said pied and steadying the grain or crystals, the product is led to a large pan, or finishing pan proper, wherein the evaporation or concentration is finished.

The above method offers several objections, owing, above all, to the intermittent way of performing the same; the periodical discharge of a large amount of evaporated syrup; the periodical reduction in the vacuum in the entire concentrating plant, every time a pan is emptied whereby the process in the entire boiling plant is interfered with and the syrups are liable to overheat, the unevenness in the consumption of steam which rises considerably when charging the "pied" and concentrating the large amount of syrup, but decreases as the juice is being concentrated. On the other hand, when charging the pans, evaporation increases with the consequent increase in the consumption of steam, but thereafter, said consumption decreases as the concentration of the mass of syrup proceeds.

In the intermittent process, crystallization also is very deficient, owing to the impossibility of constantly maintaining a suitable degree of oversaturation, as when fresh syrup is being introduced, such oversaturation ceases and will only be reestablished as the concentration proceeds, so that only during a very short time such favourable degree of oversaturation is secured. With regard to the efficient operation of the evaporating pans, serious troubles are also encountered, owing to the fact that the pans will operate with a maximum effect only during the initial stage of filling and when the body of syrup only partially or just covers the heating means; the circulation of the body of syrup (an essential factor of efficiency) gradually slowing down as filling continues, and further owing to the increasing amount of syrup bearing on the evaporation surface, the transmission of heat and consequent evaporation will become less and thus impair the efficiency of the whole process.

A continuous process has been also pro-

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posed wherein a sugar or like solution is passed through a boiling apparatus divided into or consisting of separate chambers. The sugar solution is injected into the first chamber wherein it is subjected to heating to effect crystallisation, the crystallisation process is then interrupted when the solution is passed into a second chamber by the addition of water or more untreated syrup thereto. The growth of the crystals is then initiated by passing the mass under treatment through the next succeeding and heated chamber without the addition of sugar solution. The mass is then passed through a further series of heated chambers wherein sugar solution is added and the growth of the crystals promoted. After this period the final boiling stage follows during which no further solution is added to the mass.

The object of the present invention is to provide an improved process for the continuous crystallisation of sugar in which the heating and injection stages are continued uninterruptedly throughout the process and without the interposition of any intermediate steps during said continuous process.

The present invention therefore consists of a process for the continuous crystallisation of sugar wherein the sugar solution is introduced into the first of a series of connected and heated pans or compartments in which the initial development of the grain or sugar crystals is performed by concentration and saturation of the solution, permitting the resulting mixture to pass in a continuous stream through the remaining compartments or pans to obtain final formation of the grain or sugar crystals to the required size by continued heating and the injection of further sugar solution to said mixture under treatment as it passes into each pan, the continued movement of the stream through the compartments or pans being obtained by withdrawing said mixture from the last of the connected pans or compartments, the rate of withdrawal of sugar being adjusted to equal the rate of entrance of sugar injected into the first compartment.

In the above improved process it is preferred that the sugar mixture is caused to pass through the connected pans or compartments continuously by connecting the pans or compartments by means of openings at gradually decreasing levels, introducing fresh sugar solution into the first pan or compartment and withdrawing the equivalent amount of concentrated or treated solution and crystals from the last pan or compartment in the connected series.

In order that the invention may be readily understood and carried into practice without difficulty, several preferred embodiments of the same have been shown by way of example in the accompanying drawings which illustrate types of apparatus used for performing the improved method. In said drawings:

Figure 1 is a diagrammatical view in vertical section of one type of vacuum pan, adopted for continuous evaporation.

Figure 2 shows a horizontal section of the same pan.

Figure 3 illustrates one manner of performing the process by the connection, in series, of several evaporating pans of the usual type.

Figure 4 shows a plan view of a type of evaporating pan in which the boiling or concentrating compartments are grouped in a circular form.

Figure 5 illustrates a vertical section of the type of evaporating pan shown in the foregoing figure.

Figure 6 is a plan view of a modified construction of evaporating pan, provided with circular compartments, and

Figure 7 shows a vertical section of the type of pan represented in the foregoing figure.

The same numbers of reference have been used to indicate like or corresponding parts in all the said views.

In the form of construction shown in Figures 1 and 2, the vacuum pan for continuous boiling or concentration, substantially consists of a body 1, of cylindrical shape, closed at its top by a cover 2, formed with a central dome 3 provided with a steam outlet 4, and within the lower part of which, formed by a bottom 5, of substantially conical shape, a tubular heating device 6 is arranged. This type of pan is connected to the condenser and vacuum pump for establishing the necessary degree of vacuum, its interior being radially divided by a certain number of partition sheets 7, so as to form, for instance, six independent compartments, indicated by the number I to VI, for performing the continuous evaporating process.

It will be evident that the details of construction of this type of pan may vary in the several cases, according to the conditions of operation, without departing from the basic principle of this invention.

With reference to figures 1 and 2, it will also be seen that through the heating device 6 extends a centrally arranged tube 8, for the circulation of the body of sugar solution or the like.

The heating device 6 is also divided, in this case, into six parts, corresponding with the divisions of the body 1, each of said parts being provided with an inde-

pendent inlet 9 for steam, and an independent outlet 10 for the condensation water. Each of the compartments thus formed is provided with all the accessories of common use in the industry such as lenses, probes, etc. The cover 2 and dome 3 are not formed with partitions, but the bottom part 5 is divided in a similar way as the heating device 6 and the body part 1, each of said compartments being provided with independent feeding means 11, discharging into said bottom.

Each of the comparments I to V are provided with a passage or channel 12, opening into the adjacent compartment. The ducts 12 are stepped in height, the first of them being higher than the second the second higher than the third, and so on, thus forming different levels of liquid in the several compartments, from the first to the last of them.

When using this type of vacuum pan, the first compartment I is furnished with syrup or the like in a continuous manner, the entrance of the liquid being adjusted in accordance with the evaporation performed, for the purpose of maintaining a uniform degree of concentration of the sugar solution, up to the so-called crystallizing or graining point, and while maintaining such concentration, the solution is allowed to overflow by the duct 12, in a continuous manner, into the adjacent compartment II. As the solution is being fed into the first compartment, it is injected with crystallizing seed or nuclei in the shape of powdered sugar, whereby at the entrance thereof into a body of highly oversaturated liquid, the initial crystallizing grain will at once form; it is not absolutely necessary to operate with said seeding, as the oversaturation in the first compartment may be carried on, if desired, to a point which will cause spontaneous formation of such grain or crystals. The initial grain necessary for the concentration may also be obtained by providing, outside of the apparatus, a suitable mixture of powdered sugar or fine sugar grain with syrup or molasses etc., and then injecting such mixture in a continuous manner in the first step of the treatment, or first compartment of the continually operating pan, or by forming the initial grain in a vacuum pan of the usual type, and then injecting the grain or crystals thus obtained in the same manner as before. In this case, the solution which passes from the first to the second compartment, already carries with it the necessary amount of initial grain for the later course of the treatment. Within the second compartment the concentration and oversaturation is maintained by means of evaporation and continuous feeding of solution at a convenient point to allow of the initial grain formed in the first compartment and fed by the duct to the second compartment, to continue its development. The oversaturation required in the mother solution, is maintained by adjusting the entrance flow in accordance with the degree of evaporation attained. From the compartment II, the liquid passes by overflowing to the compartment III, and from this latter to the following one, and so on, until arriving at the last of said compartments. In all the said compartments, the mother solution is gradually being concentrated by evaporation and the continual feeding of fresh amounts of sugar solution or the like. Oversaturation is maintained in said compartments at a suitable degree for the crystallization of the initial grain which, during its passage through the several compartments, will develop and gain in size by the crystallization of sugar from the mother solution.

After passing through all the several compartments, the grained sugar solution will arrive at the last of them, where the oversaturation of the mother solution will have attained a reasonable maximum, called point of discharge, for the efficient draining of the mother solution, while recovering, in shape of crystals, the highest possible amount of dissolved sugar.

The liquid passes in a continual flow to the last compartment, in which it is continually concentrated by the action of the respective heater. From this compartment the concentrated mass is continually withdrawn, to an amount adjusted to the rate of entrance, by means of a pump, conveniently connected to the outlet duct 13 for the treated mass. The continual extraction of treated liquid from the last compartment will of course give rise to a difference of level, whereby the solution is caused to flow from one compartment to the next following by the overflow ducts, and will thus pass through the entire series.

In the modified embodiment shown in Figure 3, the several operations of continuous concentration are performed in individual pans, in replacement of the compartments I to VI. The sugar juice, syrup or molasses is fed to the pan I, where the same is concentrated by means of steam entering by the inlets 9, and the heat of the heating devices 6, until attaining the necessary degree of oversaturation for developing the grain. The entrance of the solution or the like, is continuous and adjusted in accordance with the degree of evaporation performed

By means of this arrangement, a continuous and uniform formation of initial crystals is secured.

As the liquid is being fed into the first pan I, the level of the body within the same tends to rise, but as the pan or compartment communicates with the next following by means of the overflow duct or trop-plein 12, the excess of liquid passes to the compartment II. The level of the liquid within this latter is kept somewhat lower than that in the former, so as to facilitate the passage of the liquid from the one to the other. In the second compartment, the evaporation of the liquid is continued by means of the heater 6 and as concentration proceeds, fresh sugar solution is introduced by continuous feeding.

In this way, the initial crystals formed in the compartment I and which have passed to the compartment II, will take shape and develop. As liquid is being fed to each compartment, its level of course will tend to rise, but owing to the provision of an overflow similar to that of the compartment I, the liquid under treatment will flow to the compartment III. In this latter, and in the following compartments indicated at IV and V, the same operation will take place, that is to say, a continual evaporation with concentration of the mother solution and a continual feeding for the purpose of maintaining a constant degree of oversaturation, adapted to the increase in size of the grain or crystals formed. The body of liquid and crystals will thus pass from one compartment to the next following, viz: from III to IV to V, in the manner above described. As the mass passes through the compartments III, IV and V and while its mother solution is being concentrated and supplied with fresh solution or molasses, the sugar crystals gradually increase in size. The final size of crystal to be obtained will depend, in the first place, on the time of boiling, or the time during which the initial grain or crystal remains in contact with the oversaturated mother solution, for this reason, the number of compartments or pans to be used will depend on the size of grain to be obtained and of the amount of initial grain or crystals formed in the first of said compartments, which may be adjusted by the formation of a greater or lesser amount of initial grain or crystals.

A more convenient method, however, would consist in arranging the several compartments in a circular group, such as shown, for instance, in figures 4 to 6.

This latter arrangement constitutes, really, a vacuum pan somewhat similar to the current type, subdivided into a number of compartments equal to the number of steps included by the concentration process. In the said figures, the manner of operating the process in the continual vacuum pan will be clearly seen. The passage of the mass under treatment from one compartment to the next following takes place by the ports 12, formed in the partition walls 7 between the several compartments. The ports or ducts 12 constitute overflow passages, with a stepped level from one compartment to another, so that the passage from the compartment I to the compartment II will be at a higher level than that of the compartment II to the compartment III, and so on, till the last compartment from which the mass is withdrawn by means of a pump connected to the outlet 13, which communicates with the conical or lowest part of the bottom 5. In figures 6 and 7, a vacuum pan is shown provided with a different means for the passage from one compartment to another, which takes place in this case, by means of a sort of passage chamber 12^1. The form of these chambers is characterized by offering an open top in the interior of the compartment from which the mass is to pass to the next following one, and by opening diagonally into the next compartment. In accordance with this arrangement, when the mass under treatment starts boiling, it will enter into the chamber 12^1, from which it will then pass, owing to the difference of level, to the adjacent compartment.

In figures 6 and 7, a diagrammatic view of the feed duct 11 is given, said duct being connected to the main line 14, subdivided into as many sections as there are compartments in the vacuum pan.

The particular nature of this invention will allow of the vacuum pans of known construction being adapted in accordance with this improved process, by combining the same to form a battery, with each of the pans performing the function corresponding to the respective step of concentration. The construction and manner of operation of the apparatus and its modifications above described will have clearly been understood and no further explanations will be required by those skilled in the art.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. Process for the continuous crystallisation of sugar wherein sugar solution is introduced into the first of a series of connected and heated pans or compartments in which the initial development

of the grain or sugar crystals is performed by concentration and saturation of the solution, permitting the resulting mixture to pass in a continuous stream through the remaining compartments or pans to obtain final formation of the grain or sugar crystals to the required size by continued heating and the injection of further sugar solution to said mixture as it passes into each pan, the continued movement of the stream through the compartments or pans being obtained by withdrawing said mixture from the last of the connected pans or compartments, the rate of withdrawal of sugar being adjusted to equal the rate of entrance of sugar injected into the first compartment.

2. Process according to claim 1 wherein the mixture is caused to pass through a series of connected pans or compartments by means of openings at gradually decreasing levels, so that the load of mixture in each compartment gradually decreases from the first compartment to the last compartment.

3. Process in accordance with any of the foregoing claims 1 or 2, wherein seeds or nuclei of crystallization in the shape of sugar powder are injected into the first pan in order to promote the formation of the initial grain or crystals of the solution under treatment.

4. Process in accordance with any of the foregoing claims, wherein the process is carried out under the action of a vacuum.

5. Apparatus for carrying out the process according to any of the preceding claims said apparatus comprising a series of individual compartments communicating one with another by means of orifices of stepped height, for the successive passage of the mass under treatment from one compartment to the next following, heating means being provided in the interior of each compartment, and means associated with each compartment for the independent admission of steam and further means for the independent discharge of condensation water from each compartment, a tube for the circulation of the mass extending through the central part of said heating means.

6. Apparatus as in claim 5 for carrying out the process according to any of the claims 1 to 4 wherein the series of pans or compartments are contained within a cylindrically shaped body the interior of which is provided with radially extending partitions to form the separate pans or compartments, each of said partitions being provided with an orifice so that adjacent compartments are in communication with one another to permit of the free passage of the mass under treatment from one compartment to the other.

7. Apparatus for the continuous crystallisation of sugar according to the process of claims 1 and 2 constructed, arranged and operating substantially as above described, with reference to either of the examples shown in the accompanying drawings and for the purposes set forth.

Dated this 25th day of February, 1944.

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46, Bedford Row, London, W.C.1.

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585,583 COMPLETE SPECIFICATION

SHEET 1

[This Drawing is a reproduction of the Original on a reduced scale.]

FIG. 1.

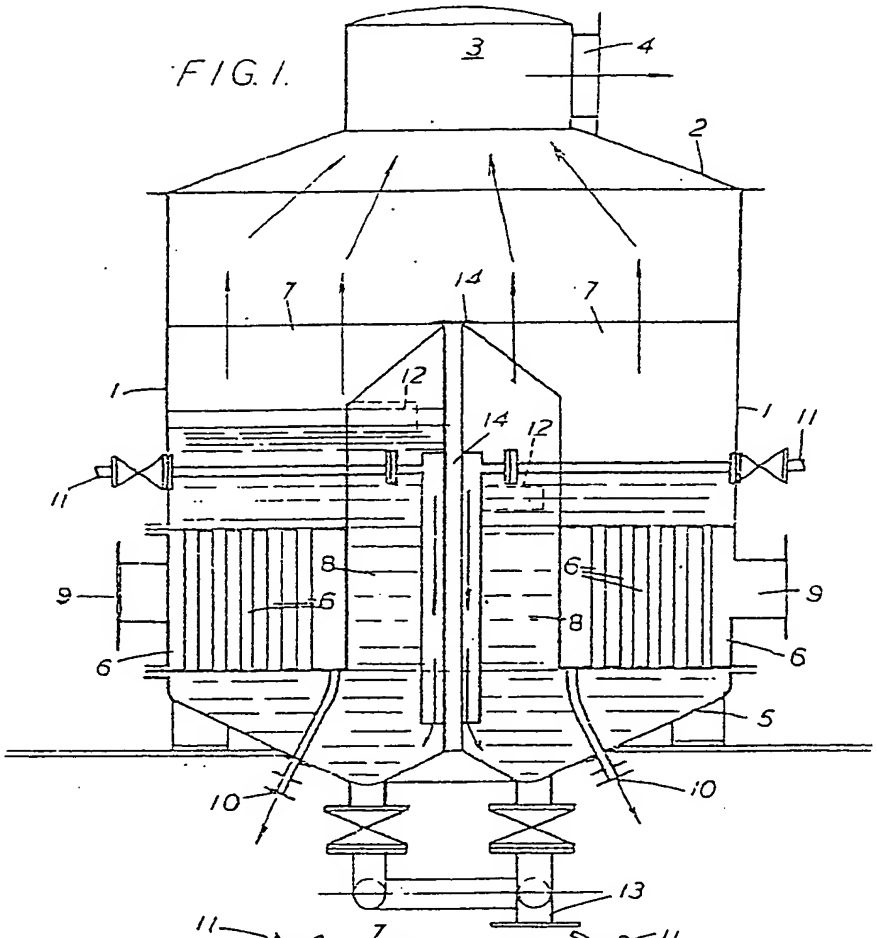


FIG 2.

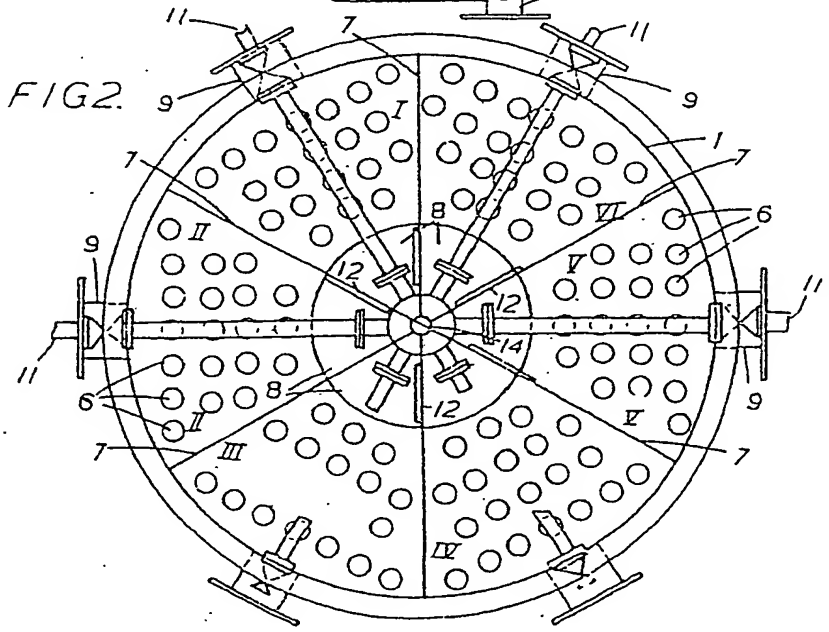


FIG.3.

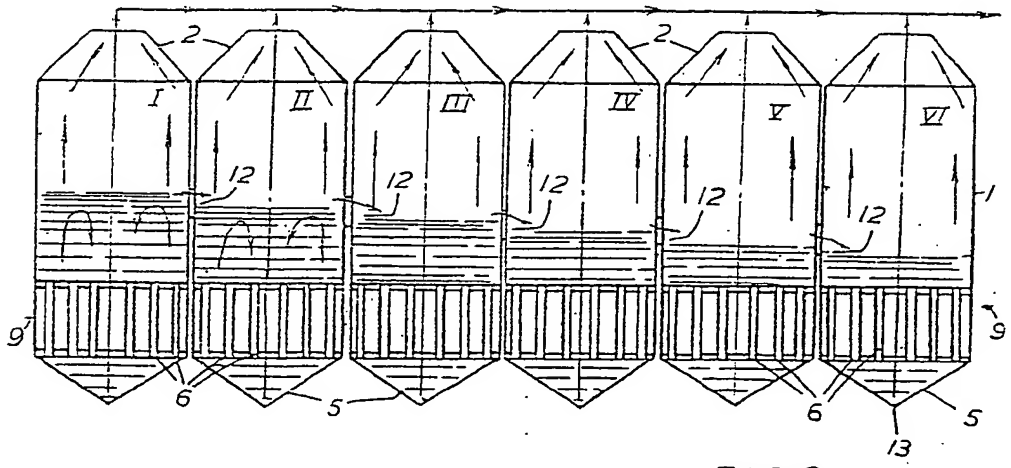


FIG.4.

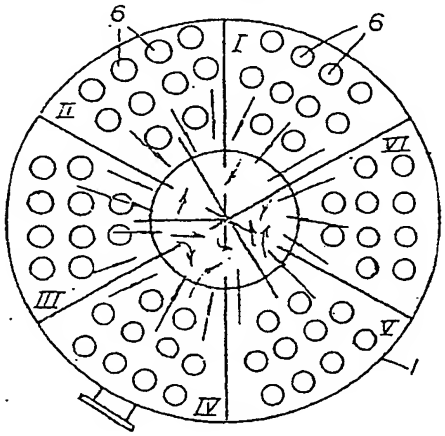


FIG.6.

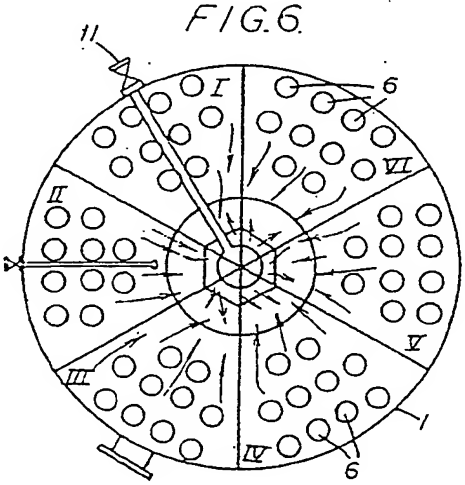


FIG.5.

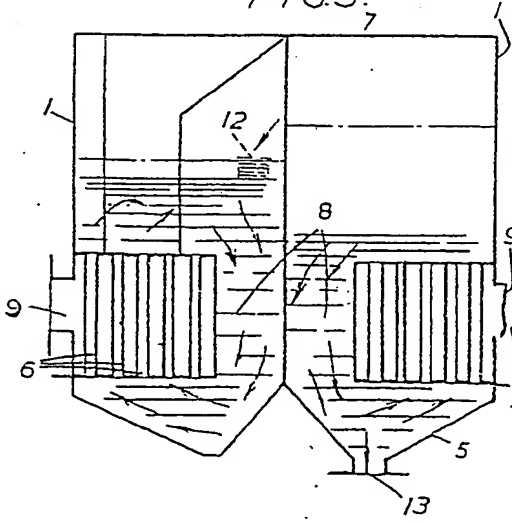
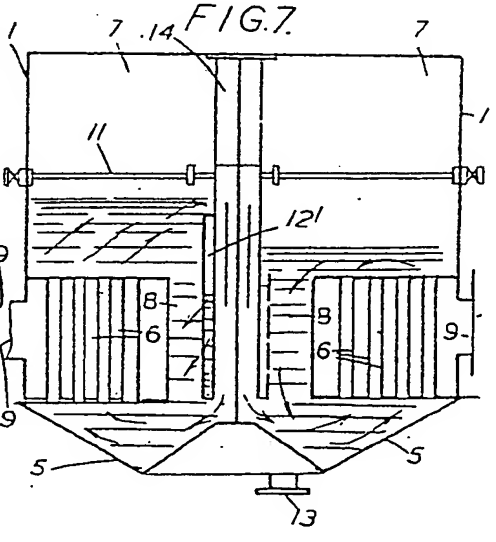


FIG.7.



H.M.S.O. (Ty.P.)

585,583 COMPLETE SPECIFICATION

2 SHEETS

SHEET 1

SHEET 2

[This Drawing is a reproduction of the Original on a reduced scale.]

FIG. 1.

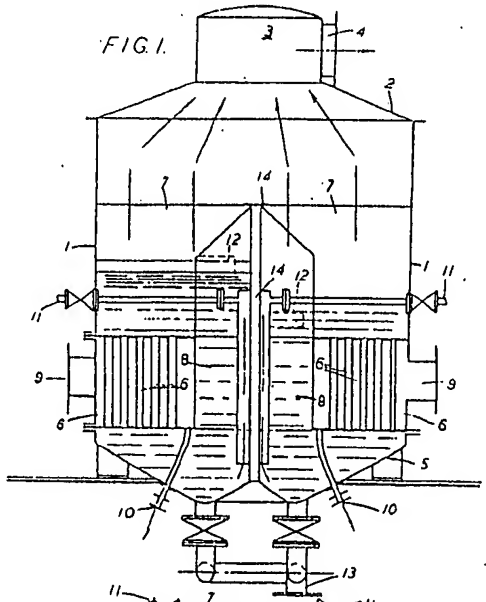


FIG. 2.

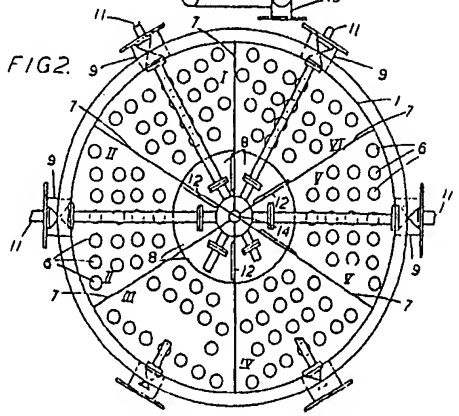


FIG. 3.

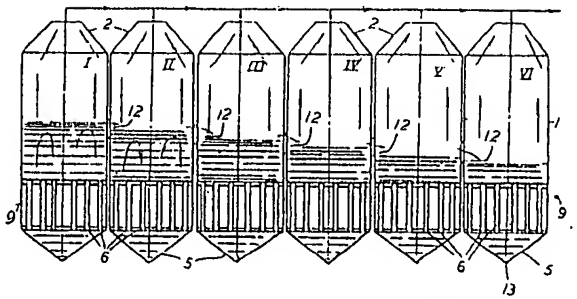


FIG. 4.

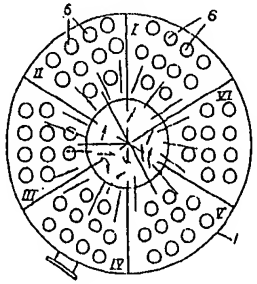


FIG. 6.

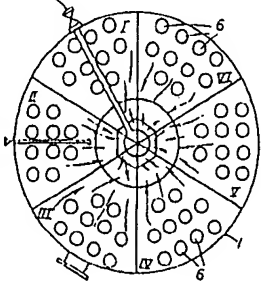


FIG. 5.

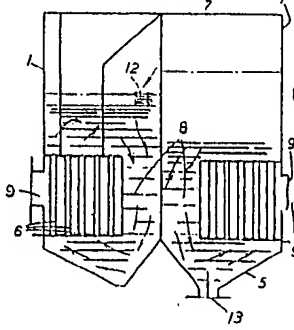
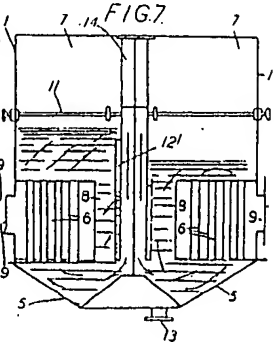


FIG. 7.



H.M.S.O. (Ty.R.)